Early Journal Content on JSTOR, Free to Anyone in the World

This article is one of nearly 500,000 scholarly works digitized and made freely available to everyone in the world by JSTOR.

Known as the Early Journal Content, this set of works include research articles, news, letters, and other writings published in more than 200 of the oldest leading academic journals. The works date from the mid-seventeenth to the early twentieth centuries.

We encourage people to read and share the Early Journal Content openly and to tell others that this resource exists. People may post this content online or redistribute in any way for non-commercial purposes.

Read more about Early Journal Content at http://about.jstor.org/participate-jstor/individuals/early-journal-content.

JSTOR is a digital library of academic journals, books, and primary source objects. JSTOR helps people discover, use, and build upon a wide range of content through a powerful research and teaching platform, and preserves this content for future generations. JSTOR is part of ITHAKA, a not-for-profit organization that also includes Ithaka S+R and Portico. For more information about JSTOR, please contact support@jstor.org.

NOTICES FROM THE LICK OBSERVATORY.*

PREPARED BY MEMBERS OF THE STAFF.

OBSERVATIONS OF THE SPECTRUM OF *NOVA PERSEI.*†

At the time of the discovery of *Nova Persei*, the two single-prism spectrographs, with which all our low-dispersion photographs of the past ten years were secured, had just been shipped to Sumatra with the Crocker Eclipse Expedition. This shipment, including likewise several minor pieces of apparatus, left the spectroscopic resources of the Observatory temporarily inadequate for the efficient analysis of the star's light. The Mills spectrograph was too powerful for a qualitative study of the spectrum, and was limited in its action to parts of the blue and violet regions. Fortunately, we possess an abundant supply of large 60° prisms, both light and dense; and from these, in connection with the Mills spectrograph, new and efficient apparatus was designed and constructed as required.

In all the spectrographs employed, and described below, the collimator section of the Mills spectrograph was used; and the changes made relate entirely to the prism-boxes, cameras, and braces for supporting the cameras. It will be a convenience in the discussion of the observations to have some ready method of referring to the different combinations of apparatus.

The Mills spectrograph, as ordinarily employed, will retain its usual designation.

The other instruments, referred to as spectrographs I, II, III and IV, will now be described.

I. A brass prism-box, designed some years ago by Mr. CAMPBELL, for converting the Mills spectrograph into a one-prism instrument, was made ready for use by the evening of February 25th. It contained a single 60° light flint prism, and carried the regular Mills camera of 406^{mm} focal length. The instrument was found to give excellent definition from above λ 3700 to λ 5700.

---

* Lick Astronomical Department of the University of California.

† Condensed from Lick Observatory *Bulletin*, No. 8.

By tilting the plate slightly, the definition was equally good from λ 4000 to λ 6000.

II. A large 60° dense flint prism, and a visually corrected triple lens of aperture 5^{cm} and focal length 53^{cm}, were mounted in wood, and attached to the collimator section of the Mills spectrograph. Most of the visual observations, and some photographs in the yellow and orange regions, were secured with this instrument. It replaced spectrograph I late in the evening of February 25th, and visual observations were obtained. The fine dark *D* sodium lines in the broad bright *D* band were seen at once, and with ease. The dark lines were compared directly with the bright *D* lines from an alcohol flame; and the star's lines were estimated by the two observers, respectively, to be displaced to the red about an eighth and a tenth of the distance between D_1 and D_2. These estimates—corresponding to radial velocities of 38 and 30 kilometers per second—were in close agreement with the photographic results [see page 231] secured a few nights later.

III. It was considered very desirable to obtain high-dispersion photographs of the *D* region. As the Mills spectrograph is limited to portions of the blue and violet, it was necessary to construct another prism-box and some auxiliary apparatus to secure the desired result. A prism-box to hold three very dense 60° prisms was constructed of wood by the Observatory carpenter, from designs by Mr. WRIGHT. The whole matter of designing, constructing, adjusting, and testing the apparatus required a day and a half. The instrument gave excellent results; no effects of flexure or shrinkage of the wood during the long exposures were visible. With the 406^{mm} camera, the separation of the *D* lines is 0.15^{mm}.

IV. Another box, similar in design to the one described in the preceding paragraph, was constructed for the purpose of photographing the *H* and *K* regions under high dispersion. It was lighter in some of its parts, and gave evidence of flexure. Results of value were secured with it, however. The three Mills prisms were used in this box, as the denser ones were entirely too yellow for work in the violet.

The comparison-lines used include those of iron, magnesium, sodium, hydrogen, and helium. Wave-length determinations have in all cases been based on the Hartmann-Cornu formula.

The spectrum was recorded from $H\delta$ to $H\beta$ on February

24th, with the Mills spectrograph. The $H\delta$, $H\gamma$, and $H\beta$ bands of hydrogen were bright and extremely broad, and were accompanied on their violet sides by very broad absorption-bands. Otherwise, the spectrum appeared to be strictly continuous. The absorption in the dark bands was only partial, so that the contrasts between bright and dark bands were very slight. The $H\beta$ bands were easily visible, but the $H\gamma$ and $H\delta$ bands were rather difficult, as a result of the too strong dispersion afforded by this instrument. The general character of the spectrum would have been shown much better by one-prism spectrograms.

On February 25th, photographs were secured with spectrograph I, and the star was observed visually with spectrograph II. Numerous bright and dark lines were easily observed; and while allowance must be made for the lower dispersion used, it is safe to say that in the region of the spectrum photographed on the preceding night, the bright bands and the contrasts between bright and dark bands were relatively much stronger. The bands appeared to be identical with those in the early spectrum of *Nova Aurigæ* (February, 1892), but in the earlier star the bands were much narrower and the contrasts were vastly stronger.

$H\alpha$ was very bright, and situated with reference to the artificial $H\alpha$ line in the same manner as the other hydrogen bands with reference to their normal positions. It was accompanied on the more refrangible side by its corresponding dark band. A very bright and broad band in the orange, presumably due to sodium radiations, was crossed by two apparently monochromatic dark lines. These were identified as D_1 and D_2. To the violet of this band was the usual absorption. It covered the normal position of D_3, but there is no reason to suspect that it related to the element helium. Besides the five well-known *Nova* bright bands in the region of λ 4860 to λ 5270 no further details could be observed visually, on account of the strong continuous spectrum which masked the fainter bands.

The spectrograms obtained on February 25th extended from λ 3830 to λ5700. One of these, enlarged 7-fold, is reproduced in the accompanying sheet of illustrations (Fig. 1). Perhaps the most striking features of the plates are the broad bright and dark H and K bands, the bright components being crossed by fine dark H and K lines (Fig. 5). The band at H is evidently the result of the superposition of the $H\epsilon$ (hydrogen) and H

(calcium) bands. The fine *H* line is apparently not so black as the *K* line, though allowance must be made for the different densities of the negative at the two places.

The violet edges of the bright bands are the more sharply defined, except for the *K* band, in which the reverse is the case. The hydrogen bands are very broad and diffuse, and it is difficult to locate the positions of maximum with accuracy. There seems, however, to be a decided shift of the maxima to the violet of the normal positions of the hydrogen lines, by an amount greater than the probable error of measurement.

The next photographs with the same apparatus were secured on March 13th, by which time the spectrum had greatly changed. These changes appear to be more pronounced in the photographs taken on March 18th, and these two sets will be considered together. The spectrograms show the *K* band to have disappeared. Most probably the *H* band shared a similar fate, though it is impossible to prove this, on account of the superposition of the $H\epsilon$ band, referred to above. The fine *H* and *K* lines remain, but the absorption in the former appears to be less complete than before. The maxima of the bright hydrogen bands are shifted several tenth-meters toward the red from the normal positions of the hydrogen lines.

It is, however, in the dark bands accompanying the bright ones that the changes are most marked. The former broad, diffuse absorption-bands are replaced by multiple fine lines. Of these lines, the one of greatest wave-length is many times the most intense, and practically terminates the bright band with which it is associated. Two other lines were observed with certainty in many of the groups, and were suspected in all the groups, except $H\zeta$, where the spectrum was too faint for reliable observation.

The displacements of the principal dark lines from the normal positions of the hydrogen lines vary considerably from one end of the spectrum to the other, but seem to be very approximately proportional to the wave-lengths. In the following tables the means of the displacements for the two dates are given in the second column, while those computed on the assumption of direct proportionality to the wave-lengths are given in the third. The assumed proportion is represented by the equation $\Delta\lambda = 0.00505\lambda$.

Line.	Δλ Observed.	Computed.	O — C	Wt.
$H\zeta$	19.28 t. m.	19.64 t. m.	— 0.36 t. m.	1
H_ϵ	20.04	19.98	+ 0.06	1
$H\delta$	20.51	20.79	— 0.28	1
$H\gamma$	22.18	22.91	+ 0.27	1
$H\beta$	25.7	24.5	+ 1.2	½

The wave-lengths in the neighborhood of $H\beta$ cannot be determined with great accuracy from these plates, on account of both the relatively low dispersion in that region of the spectrum and the unsatisfactory nature of the comparison-lines available for measurement. In the determination of the constant of proportionality the $H\beta$ result was therefore given weight one-half. Considering the unsymmetrical distribution of light on the two sides of the absorption-lines, it is safe to say the residuals (O — C) are commensurate with the errors of measurement. The proportionality of the displacements of the dark hydrogen lines to their wave-lengths therefore appears to be a fundamental characteristic of the star's spectrum at this stage of its development.

We shall refer to the displacements of some of the other dark lines, the origins of which are open to little doubt. While the dark *H* and *K* bands were in evidence, they were displaced toward the more refrangible end of the spectrum by about 16.5 t. m. On account of the breadth of the bands, the measured displacement is liable to an error of perhaps two tenth-meters. The displacement computed by means of the proportionality assumed above is 20 t. m. The displacement of the dark *D* band (due to sodium), which will be referred to below, is 27 t. m. The error of measurement of the position of this band is influenced by its breadth, and to some extent by the sensitiveness-curve of the "isochromatic" plate used, which is very steep in this region of the spectrum. The tendency would be to make the measured displacement smaller. The computed displacement is 30 t. m.

The computed displacements given above depend, as has been said, on measurements of the fine hydrogen lines which developed after the calcium bands had disappeared, and probably after the spectrograms of the *D* band had been secured. It might therefore seem more reasonable to compare the displacements of the calcium and sodium bands with those of the diffuse bands of hydrogen which existed simultaneously with them, and resembled them somewhat in their general characteristics. The displacements of the hydrogen bands are —

Line.	$\Delta\lambda$
$H\delta$	– 19 t. m.
$H\gamma$	– 19
$H\beta$	– 24

From these we obtain the equation $\Delta\lambda = 0.0046\lambda$. The observed displacements, and those computed on this basis, are —

Line.	$\Delta\lambda$	
	Observed.	Computed.
K	– 17 t. m.	– 18 t. m.
H	– 16	– 18
D	– 27	– 27

The agreement is closer than that resulting from the first assumption. There is, then, no evidence that the position of the bands is affected by other considerations than that of wave-length.

The other features of the spectrum are shown in the reproduction of one of the plates of March 18th (Fig. 2), directly enlarged from the original negative.

The spectrograms for February 25th and March 18th are not strictly comparable on the red side of $H\beta$, for the reason that the plates used on the two dates were of different character. The earlier spectrogram was made on a Cramer isochromatic plate, and the later one on an ordinary Cramer Crown, a plate not sensitized to the lower rays. In all of the plates secured on March 13th and 18th, the region λ 4600–λ 4700 was overexposed, and the details thereby destroyed.

During the early part of April the appearance of the spectrum was as is indicated in Figure 3. The triple absorption-lines referred to above had so decreased in intensity as to make their recognition very uncertain. A broad and diffuse absorption had developed in the neighborhood of the normal position of the three principal hydrogen lines. $H\zeta$ is just on the limit of visibility on the photographs, and no details can be observed with certainty in that region. The spectrogram of April 5th was made on a Cramer isochromatic plate, as was also that of February 25th, so that the two should be comparable.

It was not possible to observe the star every night over a long period of time, for the purpose of detecting rapid variations in the spectrum; such ones, for instance, as might accompany the more or less periodic changes in the star's brightness. In general, it was noticed during the spring months that the bright bands were relatively more intense at minima than at maxima of the star's brightness; that is, that the variations affected the continuous spectrum more than the bright lines. We recognize that physiological effects may play an important part in such estimates, however. Definite changes certainly occurred between April 1st and 5th. The bands λ 4629 and λ 4675, appearing on the spectrogram of April 5th, are not on that of April 1st; and the bands of April 1st at λ 4583 and λλ 4632–4661 are not recorded on that of April 5th. The band at λ 4675 was too faint to record itself on the earlier photograph. The changes described could be caused by variations in the relative intensities of one or two of the bands concerned.

The absence in Sumatra of the principal parts of the large visual spectroscope prevented visual measurements of the spectrum. There was little need for these, however, as the isochromatic plates afforded vastly more valuable observations down to and including the *D* region; and the *Hα* band was photographed with erythro plates, as well as observed visually. In February no bright bands were visible except those which have been mentioned above or described in the tables. As the star grew fainter, additional bands were observed. At the times of the last visual observations, on April 14th and 21st, essentially all the bands observed in the early sprectrum of *Nova Aurigæ* were present. Those at λ 5760, λ 5840, λ 6160, and λ 6300 were easily seen. The last photographic observation was secured on April 14th.

The spectrum was observed visually on two evenings, with instrument I, for the purpose of determining whether the light of the star was plane-polarzied to any extent. The slit was opened wide, and a Nicol prism was held in front of the eyepiece. As the prism was rotated, no narrowing of the lines, or other phenomena, were observed, except a slight darkening of the spectrum as a whole, due to the polarizing effect of the spectroscope. The results furnish no evidence of a Zeeman effect in the star, but in some respects the evidence is merely of a negative character.

The velocities in the line of sight determined from measurements of the fine dark *H* and *K* calcium lines on all the plates secured up to and including March 18th, with spectrograph I, are contained in the following table:—

Date	Plate No.	Velocities. *H*	*K*
Feb. 25	2023C	-4^{km}	$+6^{km}$
	2025C	$+2$	$+5$
	2026D	——	$+13$
Mar. 13	2049C	-6	$+13$
	2050D	$+22$	-4
Mar. 18	2056C	——	$+14$
	2057D	$+7$	$+7$
	Means	$+4.2^{km}$	$+7.7^{km}$

These values are corrected for the orbital motion of the earth, but not for diurnal motion and the curvature of the spectrum lines. These corrections are -0.2^{km}, and -0.3^{km}, respectively. Applying them to the mean of the individual determinations, we have $+5.7^{km}$ per second as the observed radial velocity of the star. This value was used in correcting all the wave-lengths determined with spectrograph I.

Recalling that the above individual results depend each upon measures of a single line, on plates secured with an instrument containing only one light flint prism, whereas the current results with the Mills spectrograph depend upon measures of many lines dispersed by three dense flint prisms, the linear values of the discrepancies are seen to be small.

A spectrogram of the *H* and *K* region secured on March 5th with spectrograph IV yielded the following velocities, from the fine dark lines:—

H, $+6.5^{km}$
K, $+8.1$

Mean, $+7.3^{km}$

A discrepancy of 2.5^{km} at $H\gamma$ corresponds in linear value to 1.8^{km} at *H*.

These dark lines were very narrow. The measured widths on the above plate were 0.22 t. m. and 0.28 t. m. respectively, including the effects of flexure of the instrument in broadening the lines.

Spectrograms of the *D* region were secured on February 26th, 27th, 28th, and March 3d, 14th, and 17th, with either low or high dispersion. While some of the low-dispersion plates are quite satisfactory, those of high dispersion are so much more so that results from the high dispersion alone will be considered. One of the latter was obtained on February 28th, and is reproduced in Figure 4. The position of maximum is apparently to the violet of the *D* absorption-lines; but the slope of the sensitiveness-curve of the plate, referred to above, would have a very strong tendency to shift the apparent maximum to the violet, so that it is impossible to locate the actual position of greatest intensity.

The radial velocities of the *Nova* determined from the *D* lines on these plates are as follows:—

Date.	Plate No.	Velocity.		Mean.	Corr. for Curv.	Red to Sun.	Velocity.
		D_1	D_2				
Feb. 28	2034C	+38.7	+33.8	+36.1	—2.7	—27.3	+6.1^{km}
Mar. 3	3040D	+33.8	+25.8	+29.8	—2.3	—27.0	+0.5

Mean velocity with reference to Sun, +3.3^{km}

In comparing these results for the *D* region with those secured from ordinary line-of-sight work in the violet region, it is necessary to bear in mind the matter of relative prismatic dispersion for the two regions. In the Mills spectrograph work at $H\gamma$ we should be satisfied if the discrepancy between the values secured from two plates, on each of which only two lines had been measured, were less, say, than 2½ kilometers per second. The linear value of the discrepancy between the above results, 6.1 — 0.5 = 5.6^{km}, would correspond to 2.4^{km} at $H\gamma$, with the Mills spectrograph.

As a check on these results, the *D* lines were measured on a spectrogram of the planet *Mars*, taken under similar conditions. The difference between the observed and computed velocities, —2.2^{km}, corresponds to — 1.0^{km} at $H\gamma$, and is satisfactory.

The *D* absorption-lines are very narrow. A comparison of their widths with those of the corresponding lines in the solar spectrum is not without interest. A measurement of one of the plates places their width at 0.8 t. m. The width of the solar lines according to ROWLAND'S tables is 0.17 t. m. It was considered better, however, to compare the two spectra under the same instrumental conditions. The widths of the *D* lines on a spectrogram of *Mars* and on one of the Sun were therefore measured, with the following results:—

Line.	*Mars.*	Width in Sun.	*Nova.*
D_1	1.0 t. m.	0.9 t. m.	0.8 t. m.
D_2	1.2	1.1	0.8

The solar and planetary lines are probably somewhat broadened by the presence of unresolved companions, but it is evident that the breadths in the two cases are of the same order. The last spectrogram of the *D* region, secured in the spring, was a low-dispersion one taken on March 17th. It showed the general features to have remained practically unchanged.

For convenience, the determinations of radial velocity referred to above are here collected:—

Spectrograph I, *H* and *K*, $+5.7^{km}$
Spectrograph III, D_1 and D_2, $+3.3$
Spectrograph IV, *H* and *K*, $+7.3$

In addition to the spectrograms on which these results depend, a number of others recorded the absorption-lines of sodium and calcium. Within the limits of error of measurement, all give accordant results. There is no evidence that the velocity is variable; and this view is strongly confirmed by the results of the summer series of observations, to be described below.

Spectroscopic observations of *Nova Persei* were discontinued from April 21st to July 9th, while the Sun was passing through this region of the sky. Our regret that the southern position of the Lick Observatory prevented observations in this period is coupled with the hope that the observatories of northern Europe were able to obtain a practically continuous series.

Our summer series of observations has been secured mainly with spectrograph I. The first observation of the series was made on July 9th. As announced by Professor PICKERING, the spectrum at this time was that of a nebula. The usual nebular lines are represented by broad bright bands. The several spectrograms obtained at well-distributed intervals since July 9th do not show that any pronounced changes have occurred in this time. Spectrograms covering the region $\lambda\,3800-\lambda\,5900$ are reproduced in Figures 6 and 8.

The *Hα* band is very bright, but no other details additional to those on the photographs have been shown by the visual observations.

A striking feature of the spectrum is the distribution of the light in most of the bands. In general, there is a maximum, considerably displaced to the violet of the normal position of the nebular line. This maximum is accompanied on its less refrangible side by a pronounced minimum. In most cases another

Fig. 1.

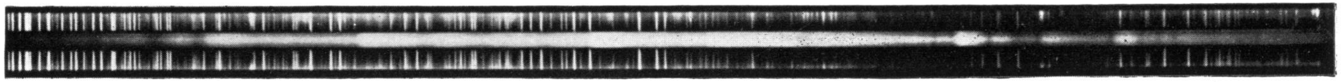

Figure 1.—*Nova Persei,* enlarged 7-fold. 1901 February 25.

Fig. 2.

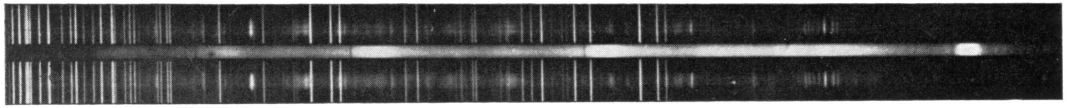

Figure 2.—*Nova Persei,* enlarged 7-fold. 1901 March 18.

Fig. 3.

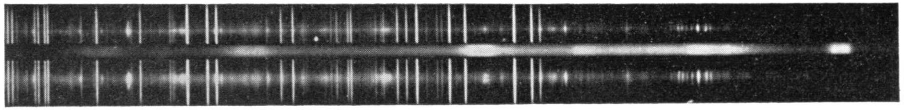

Figure 3.—*Nova Persei,* enlarged 7-fold. 1901 April 5.

Fig. 4.

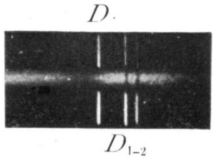

Fig. 5.

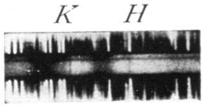

Figure 4.—*Nova Persei, D* region, enlarged 8-fold. 1901 March 3.

Figure 5.—*Nova Persei, H* and *K* region, enlarged 9-fold. 1901 February 25.

Fig. 6.

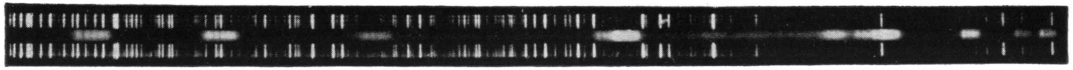

FIGURE 6.—*Nova Persei*, enlarged 7-fold. 1901 July 15.

Fig. 7.

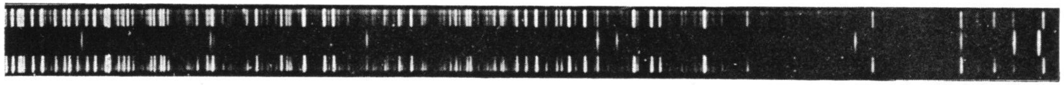

FIGURE 7.—N. G. C. 7027, enlarged 7-fold. 1901.

Fig. 8.

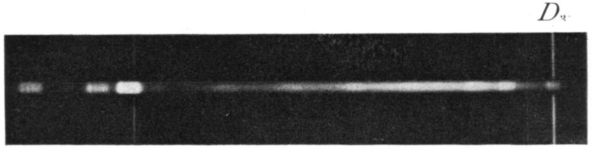

FIGURE 8.—*Nova Persei*, enlarged 8-fold. 1901 August 11.

Fig. 9.

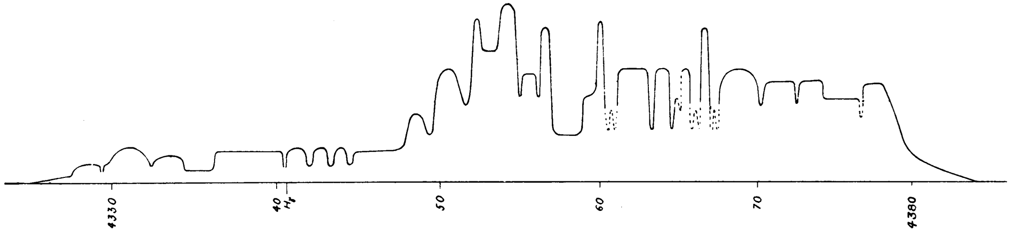

FIGURE 9.—*Nova Persei*, $H\gamma$ region, high dispersion. 1901 September 3.

minimum appears to the red of this, and in some of the bands there are additional minima. The one nearest to the maximum is in each case the strongest. While we have, of course, no knowledge as to the origin of these minima, their appearance certainly suggests that they are absorption phenomena, and they will be referred to as such. Though most of the bands conform to a general type, they are not by any means duplicates of one another. In some cases the principal absorption-line alone was identified with certainty, while in others lines apparently not belonging to the series were strongly suspected. In a number of instances the appearance of the bands was indicative of such complexity of structure as to make it impossible to consider more than their general features in a preliminary study of this sort. It is quite possible that some of the absorption-lines are due to gases in the atmosphere of the star, which are not directly involved in the production of the bands. In fact, this actually occurs in the case of the *D* sodium lines and the *H* calcium line. The latter appears as an absorption-line in the band λ 3947–λ 3988. There is little reason to doubt that its companion, the *K* line, is absent only by reason of the fact that there the calcium vapor has nothing to absorb.

Another cause of complexity is the overlapping of bands. This occurs in at least three cases:—

1. The bands corresponding to λ 4340.6 ($H\gamma$) and λ 4363 (nebular line) are involved in the composite band λ 4325–λ 4385.

2. Those belonging to the nebular lines λ 4685.9 and λ 4713.2 (helium) are superposed in the band λ 4669–λ 4746. There are, in fact, circumstances which indicate the presence of still another component in this band. It will be seen by referring to Table IV that there is a maximum at λ 4714, brighter than the one at λ 4703, and which cannot be accounted for by the superposition of the two bands to which reference has been made, assuming them to be of normal type. In addition, there are absorption-lines at λ 4719 and λ 4725.7. These effects would be produced by a superposed band of the regular type corresponding to a line of normal wave-length λ 4724. Moreover, judging from the other bands, the band whose maximum is at λ 4703 should vanish at about λ 4733, whereas the composite band in question extends to λ 4746. The extension may, however, be due to the nebular line λ 4743±, the presence of which is partially indicated by an absorption-line at λ 4736. While the complexity of the band is

such that a final statement of its composition is impossible without further study, the hypothesis of a line normally at λ 4724 is advanced as furnishing a plausible explanation of the structure of the broad band.

3. The band λ 3953–λ 3984 was supposed at first to be the broadened $H\epsilon$ line; but on this supposition the line is unduly strong. The $H\gamma$ band is very bright, $H\delta$ is fairly bright, and the λ 3969 is very bright, whereas $H\zeta$ and the rest of the ultra-violet hydrogen series do not appear. Furthermore, the displacement of the maximum of this band to the violet of the normal position of $H\epsilon$ was greater by about two tenth-meters than that of the other maxima in this region of the spectrum. Some spectrograms of well-known planetary nebulæ recently secured by Mr. WRIGHT fully explain these peculiarities. In all previous work on the nebulæ, the line recorded at this point in the spectrum has been regarded as single, and has been assumed to be $H\epsilon$. The line is in reality a wide double, as shown in the reproduction of the spectrum of N. G. C. 7027 (Fig. 7). The component of greater wave-length is the $H\epsilon$ hydrogen line, at λ 3970.2; it is very faint. The more refrangible component, at λ 3967.6, is much the brighter of the two, and appears to be a characteristic strong nebular line, not previously observed. The positions and relative intensities of these lines leave no doubt that the *Nova* band at λ 3453–λ 3984 corresponds almost entirely to this nebular line at λ 3967.6, and is scarcely influenced by the $H\epsilon$ radiations.

In order to investigate the displacements of the maxima of the star-bands, from the normal positions of the lines in the nebulæ, it was found necessary to make more accurate determinations of the wave-lengths of some of the nebular lines than were available. An investigation with that end in view was therefore undertaken by Mr. WRIGHT, and some of the preliminary results will be used in this paper. The following table gives the displacements of the maxima and of the absorption lines of all the bands of the *Nova* which have been identified as being of nebular origin. The first column contains the normal wave-lengths of the lines in nebular spectra, the second the displacements of the maxima, and the third the computed displacements on the assumption of proportionality of displacement to wave-length, according to the empirical formula $\Delta\lambda = -0.00212\lambda$. The following four columns contain the measured displacements of the absorption-lines which appear to belong to the bands.

Positive and negative signs indicate displacements toward the red and violet ends of the spectrum, respectively. Both the maxima and the minima appear to be displaced in proportion to their wave-lengths. The observed widths of the bands are given in the eighth column, as far as they can be determined; but it should be said that the photographic widths are affected both by their intensities and by the sensitiveness-curve of the plate. The red edge of the band at λ 5876 is practically at the limit for isochromatic plates. The wave-lengths of the principal bright bands observed in *Nova Aurigæ* in August, 1892, by Mr. CAMPBELL, are contained in the last column. That star was of the 10.5 magnitude, and the photographs did not cover the ultra-violet regions.

TABLE I.

Wave lengths in the Nebulæ.	DISPLACEMENTS.						Width of Bands.	Principal Bands *Nova Aurigæ*.
	Max. Obs'd.	Max. Com'd.	Min. Obs'd.	Min. Obs'd.	Min. Obs'd.	Min. Obs'd.		
3868.9	— 8.7	— 8.2	—4.8	+0.8	+6.0	+10.0	31	
3967.6	— 8.6	— 8.4	—4.9	+1.1*	(+3 8)		31	
4101.9	— 8.2	— 8.7	—4.8	+1.	+7		36	4098
4340.6	— 9.4	— 9.2	—5.					4336
4363.3	— 9 7	— 9.1	—5.2	+1.4			33	4358
4471.6	— 9.6	— 9 5	—5	(0)			34	4466
4643±	—11	—10	—8					4630
4685.9	—10	—10	—5	+3		+10		4681
4713.2	—10	—10	—5					471-
4743			—6					
4861.5	— 9	—10	—6	+1	(+7)	(+11)	33	4857
4959.0	—11	—11	—6	+2			34	4953
5007.0	—11	—11	—6	+1			38	5002
5752	—11	—12	—6			+16	43	5750
5875.9	—13	—12	—7	+1			40	
6563†								

Parentheses indicate that the line was only suspected. The absorption in most of the lines is incomplete, so that the bringing out of any particular one is largely a matter of exposure and development. It is quite possible that other lines exist which will appear in a final comparison of all the sprectrograms secured.

The nebular character of the *Nova* spectrum at present is evident from the measures published in the tables, and may be seen at a glance by comparing Figures 6 and 7. All of the principal bands correspond to lines known to exist in the nebulæ.

---

*The dark line *H* falls in this place, and determines the exact position measured.

†The very bright *Hα* band was observed visually, but no attempt was made to photograph it in the summer series.

A comparison of the first and last columns of Table I shows that the spectrum of *Nova Aurigæ* is very closely related to that of *Nova Persei.* The absence of the bands at λ 5876 and λ 6563 from the former star is no doubt explained by the fact that it was more than four magnitudes fainter than the present star; and it is probable that the bands at λ 3869 and λ 3968 were not recorded in 1892 because no auxiliary correcting-lens was used to eliminate the chromatic aberration effects of the 36-inch objective. The bands in the present *Nova* are vastly wider than in that of 1892, and the distribution of light within the bands seems to be different. The positions of corresponding maxima differ about five or six tenth-meters in the two cases. Perhaps the most remarkable features of the 1892 spectrum were the bands observed by Mr. CAMPBELL at λ 4358 and λ 5750. The λ 4358 band, in August, 1892, was estimated to be at least eight times as bright as the $H\gamma$ band, but in November, 1894, it had become fainter than $H\gamma$; and the band at λ 5750, so easily observed in 1892, had become extremely difficult in 1894 (*Astrophysical Journal*, Vol. I, pp. 49–51). These two bands are now very prominent in *Nova Persei;* and it is probable that they will diminish in brightness, as in the case of the earlier star. Corresponding to these two bands, there are faint lines in the well-known nebulæ.

The radial velocity of *Nova Persei*, determined from the *H* absorption-line of calcium, was $+ 6^{km}$ on July 15th, and $+ 12^{km}$ on July 24th. The mean of the two determinations is in satisfactory agreement with the value, 5^{km}, afforded by the *H* line in the spring series.

At the time of the spring observations, the *D* absorption-lines occupied positions near the middle of the broad *D* bright band, as shown in Figure 4; and the D_3 comparison fell near the more refrangible edge of the band. In the summer observations, the D_3 comparison-line (Fig. 8), falls near the middle of the bright band, and the sodium comparison-lines are situated at the extreme red edge of the band. A long exposure made on August 12th records this bright band to about the wave-length λ 5902, and the sodium *D* absorption-lines are clearly shown to be present. Within the limits of error of measurement, they occupy exactly the same positions as in the spring observations. Corroborative evidence is thereby afforded that the radial velocity of *Nova Persei* has been practically constant.

A number of the bands have recently been photographed with a dispersion of three dense flint prisms. They all appear to have the same general features, as follows: A pronounced maximum is near the violet edge of the band, flanked on either side by a subordinate maximum. To the red of this group is a broad minimum, or absorption-line, while still farther to the red is a group of maxima and minima giving the appearance of four absorption-lines. With low dispersion this group was observed in most of the bands as a broad and diffuse absorption-line (see Table I, column 5). An intensity-curve drawn from a Mills spectrogram of the band at λ 435 is reproduced in Figure 9. Further than to note these general characteristics, the spectrograms referred to have not been studied.

The bearing of the foregoing observations upon the various theories of new stars is reserved for a future paper.

It is greatly to be regretted that the delicate details of the original negatives are so largely lost in the reproductions.

Acknowledgments are due to Dr. H. M. REESE for assistance in taking many of the photographs and in reducing some of the measures.

W. W. CAMPBELL,
W. H. WRIGHT.

September 12, 1901.

MOTION IN THE FAINT NEBULA SURROUNDING *NOVA PERSEI.*[*]

A negative was secured with the Crossley reflector on the nights of November 7th and 8th of the region about *Nova Persei*, having a total exposure of $7^h\ 19^m$. Very faint nebulosity is shown on all sides of the *Nova*, the most pronounced being to the south. Several broken and irregular streamers are shown in this direction to a distance of 6′ from the *Nova*, while the brightest mass of all is very close to the star on the southwest side, so close as to appear to join it. There are several quite well marked condensations in the form of wisps on the outer edge of the nebulous area to the south. This series of wisps is concave toward the *Nova* and forms a streamer which may be the outer portion of a spiral or a portion of a conic section other than a circle. The end of this streamer farthest from the star is the strongest and is of a very peculiar forked form. To the north there is considerable very faint nebulosity, but without any particular structure.

---

[*] Abstract from Lick Observatory *Bulletin*, No. 10.